

**HIGH VOLTAGE RIPPLE REDUCTION  
AND SUBSTRATE PROTECTION**

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**ABSTRACT OF THE DISCLOSURE**

In a non-volatile memory, charge pumps are used to provide high voltages needed for programming memory cells that have floating gate structures. Charge pumps have a series of voltage multiplier stages in series to boost voltage. These charge pumps must rapidly charge a load to a high voltage and then maintain a voltage with a high degree of stability. Techniques for achieving both of these goals are presented. In one aspect, a charge pump has two operating states, one to charge a load rapidly and a second to maintain a voltage on a charged load with high stability. These states are achieved by changing the current output from a high current during charging to a low current to maintain the voltage. This is done by changing the capacitance used in the individual voltage multiplier stages. In another aspect, two different current levels are produced by changing the voltage used to charge the capacitors of the voltage multiplier stages.